MAPPING OF POSTGLACIAL ICELANDIC LAVA FLOWS AS ANALOGUES FOR MARS. E. Hauber[1], T. Platz[2], L. Le Deit[1], O. Chevrel[3], B. Hoffmann[1], L. Kuhlmann[1], F. Trauthan[1], F. Preusker[1], R. Jaumann[1], [1]Institut für Planetenforschung, DLR, Berlin, Germany, Ernst.Hauber@dlr.de, [2]Institut für Geologische Wissenschaften, FU Berlin, Berlin, Germany, [3]Department für Geo- und Umweltwissenschaften, LMU München, Germany.

Introduction: The mapping of lava flow volume and morphology can provide insights into the geologic framework of basalt petrogenesis [1], the rates of magma supply and the nature of lava emplacement behavior [2], and rheological properties [3]. Mapping of lava flows on extraterrestrial surfaces, however, is commonly complicated by a lack of detailed topography, by lava flow degradation, and in particular on Mars, by wide-spread dust mantling. Mapping of terrestrial analogue lava flows is therefore important for any attempt to interpret planetary data despite the limitations of remote sensing data. We performed an airborne flight campaign to generate high resolution images and topographic data of postglacial lava flows in Iceland as analogues to basaltic lava flows on Mars. The remote sensing data were mapped to determine the overall extent and morphology of lava flows, and field work was conducted to verify and refine the mapping results and to collect samples for further laboratory analysis (mineralogy, chemistry, rheology). The combination of photogeological mapping, field mapping, and laboratory data improves our ability to infer compositional and rheological information from the mapping of planetary data, and to assess emplacement conditions and controls. Here we report on our lava flow mapping and preliminary field work results.

Data: An airborne version of the High Resolution Stereo Camera, HRSC-AX, was used for the acquisition of stereo and color images. HRSC is a multi-sensor pushbroom instrument with 9 CCD line sensors. The particular value of HRSC is the stereo capability, which allows to systematically produce high-resolution Digital Elevation Models (DEM). The principles of HRSC-AX data processing follow that of HRSC processing. The orientation data of the camera is reconstructed from a GPS/INS (Inertial Navigation System). The flight campaign in Iceland in Summer 2006 covered several regions, including parts of the Western Volcanic Zone (WVZ). Orthophotos have a map-projected resolution of 25 cm pixel^{-1}, and DEM have a vertical resolution of 10 cm, an absolute accuracy of ~20 cm, and a horizontal grid spacing of 1 m.

Geologic Background: The WVZ was a prior zone of major rifting on Iceland (from ~6 to 2 Ma), but is now much less active (3-7 mm/yr) [4] and can be considered an ultra-slow spreading center. The geology of our study area is characterized by NE-trending subglacial hyaloclastite ridges and a large subglacial tuya, which are embayed by postglacial lava flows. The lava flows, most of which were erupted in the first ~3000 yrs after glaciation, have a composition in agreement with melting of primitive mantle [5]. Lava shields (e.g., Skjaldbreidur and Lambahraun, both north of our study area) and fissure eruptions are observed in the WVZ [5,6]. Several NE-trending faults and fissure swarms cut the postglacial lavas [7].

Morphology: The focus of this study is on the postglacial lava flows and shields. Ubiquitous vents and fissures can be observed. Vents (Fig. 1a) are often craters with rims consisting of scoria and partly welded spatter. Lava flows consist of vesicular basalt (Fig. 1b), have well expressed flow margins, and display inflation features (e.g., tumuli,; Fig. 1c). Most lava flows are covered by moss, the type and thickness of which can sometimes be used to differentiate between lava flows of different age. Lava flow textures are commonly characterized by ropy pahoehoe (Fig. 1d), but blocky lavas are also found. Lava flow occurred both in lava tubes (Fig. 1e) and as open channel flows (Fig. 1f). Many partly drained channels suggest that these lava flows were volume-limited.

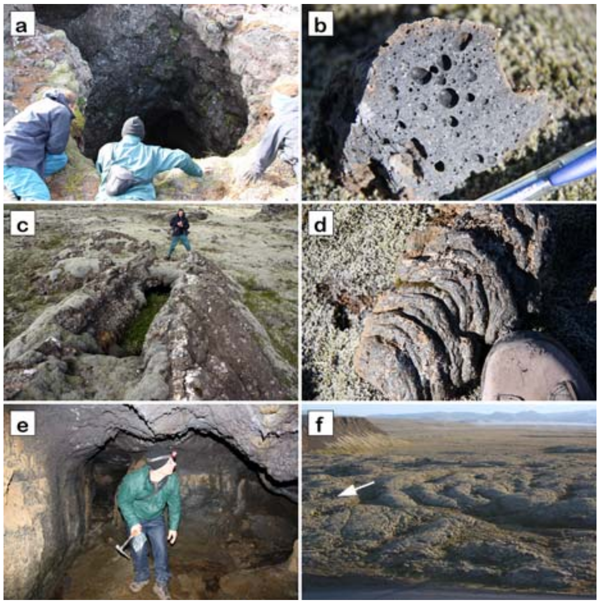

Fig. 1. Surface morphology of the WVZ as seen in the field. (a) Vent of lava flow investigated in this study. (b) Close-up view of vesicular basalt (pen at lower right for scale). (c) Lava inflation feature (person for scale). (d) Ropy pahoehoe texture, typical for lava flows in the study area (tip of boot at lower right for scale). (e) Inside a lava tube. (f) Oblique view of an open channel lava flow with pressure ridges (flow direction from right to left, person (arrow) for scale).

Mapping: Lava flow mapping was done for a selected lava flow. We used false-color ortho-images (Fig. 2a), shaded DEM (Fig. 2b), and slope maps (Fig. 2c) to delineate the boundaries of relevant landforms (Fig. 2d). Lava transport is predominantly in lava tubes near the first 1-1.5 km from the vent. After a sharp break in slope (about halfway down the lava flow; "A" in Fig. 2c), the flow continues in open-channel flow conditions over very shallow topographic slopes. The total length of the flow is about 4 km. It proved to be difficult (but possible) to identify the correct location of the vent in image data (confirmed by field inspection). It is even more complicated to find the source vents of Martian lava flows, and our results suggest that an unambiguous identification will only be possible in a few fortunate cases. Our results also show that the preexisting topography is a significant factor in determining the final shape of a lava flow. In turn, the observation of changes in flow morphology may allow to infer topographic variations even for planetary surfaces where no topographic data are available. Further work will combine the results of our mapping with laboratory results on rheology, allowing to test rheological flow models that are based on lava flow morphometry.

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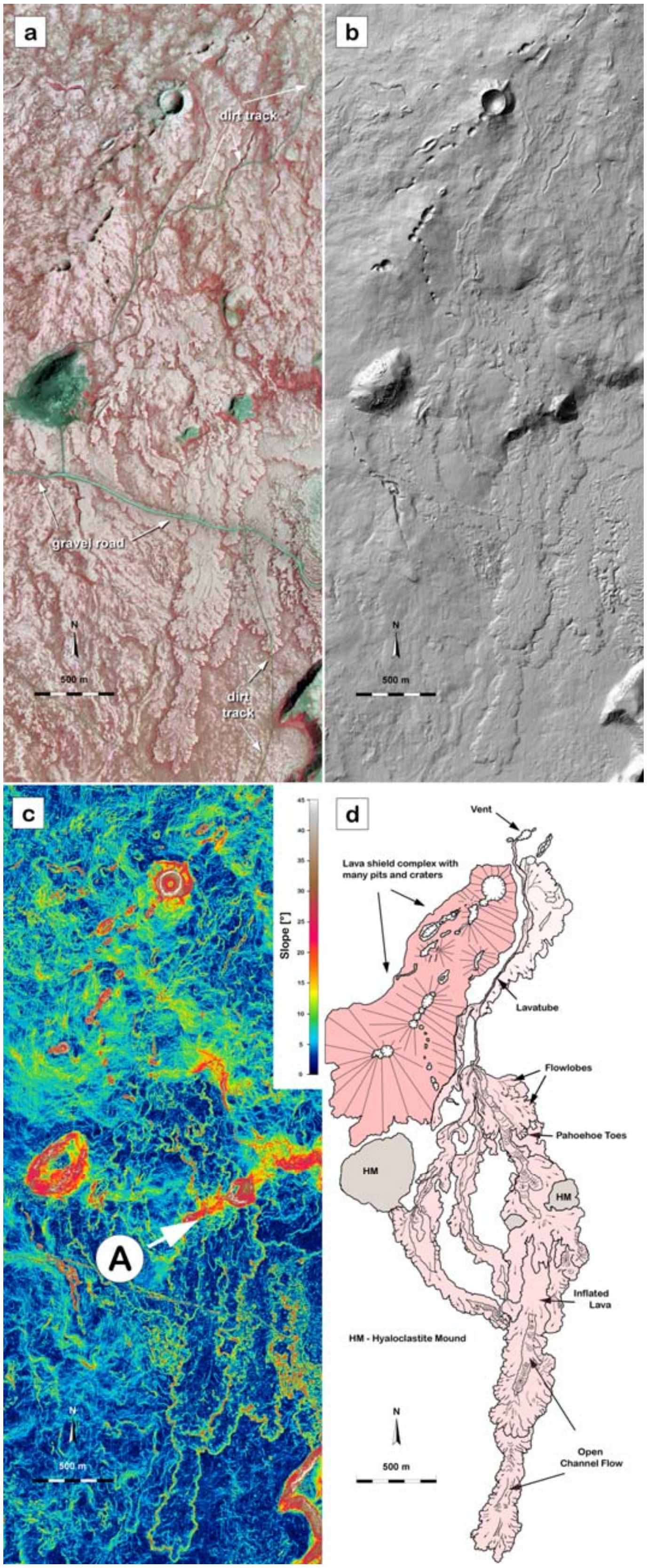

Fig. 2. HRSC-AX data and preliminary geomorphologic map of a lava flow in the western Volcanic Zone of Iceland (~64.220°N/20.933°W). (a) False-color orthoimage composed of near-infrared, red, and green channel. Red tones mark vegetation (mostly moss). (b) Shaded DEM derived from HRSC-AX stereo images (artificial illumination from NW). (c) Slope map derived from HRSC-AX DEM. Note sharp break at "A". (d) Preliminary geomorphologic map of lava flow. Light red color marks lava flow, dark red marks a complex lava shield with many pits and craters, and grey-brown areas mark several hyaloclastite mounds.